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A NEW FOSSIL GLEICHENIACEOUS FERN FROM ILLINOIS

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THE ONLY KNOWN GENUS of Paleozoic ferns attributable to the family Gleicheniaceae is *Oligocarpia* Goeppert. The sorus is of the gleicheniaceous type although the complete details of its anatomy are insufficiently known. The genus has been the subject of considerable study because of its great antiquity and significant relationship. *Oligocarpia* is probably exclusively Paleozoic in age but several authors have included Mesozoic species in the genus.

The living Gleicheniaceae include two genera and eighty species. *Gleichenia* has seventy-nine species which are chiefly distributed in tropical regions, and *Stromatopteris*, endemic to New Caledonia, is monotypic. No species of the family occur in the existing north temperate flora.

Sometimes a third genus, *Platyzoma*, is recognized. This genus contains only one species occurring in northern Australia.

The oldest undoubted Gleicheniaceae occur in the Triassic of Switzerland, and soon thereafter the group became widely distributed over the world. It seems probable that the family attained its maximum development during Cretaceous times, and that it has gradually declined since the beginning of the Cenozoic.

Oligocarpia antedates the Triassic and thus is older than any of the typical members of the family. It has been observed that the fructification of *Oligocarpia*, though distinct, bears close resemblance to those fructifications characteristic of the Gleicheniaceae.

Six species of *Oligocarpia* have been reported from Carboniferous rocks of North America: *O. gutbieri* Goeppert, *O. alabamensis* Lesquereux, *O. flagellaris* Lesquereux, *O. missouriensis* D. White, *O. kansasensis* Sellards, and *O. brongniarti* Stur.

In a collection of fossil plants from the Mazon Creek beds recently sent to the Botanical Museum of Harvard University by Mr. F. O. Thompson of Des Moines, Iowa, there are excellent fruiting examples of a typical *Oligocarpia* which cannot be referred to any of the described species. It is noteworthy that Lesquereux labelled similar sterile specimens and one poorly preserved fertile specimen as "*Pecopteris sp. nov.*" I propose to name this species *Oligocarpia vera*.

This new species is especially interesting because each sporangium possesses a uniseriate annulus. Serial transverse sections were made through 20 sori by the nitrocellulose peel method. It was possible to take from 8 to 14 peels per sorus. The etching solution necessary to dissolve the mineral matrix away from the "carbonized" sorus was 5% hydrochloric acid.

OLIGOCARPIA *Goeppert* 1841 Gattungen der Fossile Pflanzen Lief. i, ii; p. 3.

Genotype: *Oligocarpia gutbieri* Goeppert pl. 4. f. 1, 2.

Original generic description: "Frons bipinnata, pinnulis aequalibus. Nervi primarii flexuosi apicem versus in dichotomias soluti, nervi secondarii simplices dichotomive, inferiores simplices ante marginem evanescentes apice sorigeri, superiores dichotomi excurrentes. Sori e

4–5 sporangiis rotundis multiarticulatis compositi."

Original specific description: "Ol. fronde bipinnata, rhachi tenui, pinnis multiiugis, pinnulis ovatis lata basi sessilibus alternis apice rotundatis crenulato-dentatis approximatis, nervo primario flexuoso sub apice pluries dichotomo, nervis secundariis simplicibus dichotomisve."

The present usage of *Oligocarpia* is that of Kidston[1] whose definition is based chiefly upon *Oligocarpia gutbieri*.

Kidston describes *Oligocarpia* as follows: "Synangia circular, formed of 3 to 5 (rarely 6) pyriform sporangia with a prominent annulus composed of two rows of cells, which passes over the apex of the sporangia and bends down the sides of their free portion. A band of small narrow cells forming a stomium passes down the ventral surface of the sporangia and indicates the part at which the sporangia opened for the dehiscence of the spores. Spores tetrahedrally developed, smooth, with a triradiate ridge on their surface. The synangia are placed singly on the lateral veinlets, and frequently occupy almost the whole of the limb between the midvein and the margin of the somewhat reduced pinnule, or are situated somewhat more to the margin. The veinlet on which the synangia are placed does not extend beyond them."

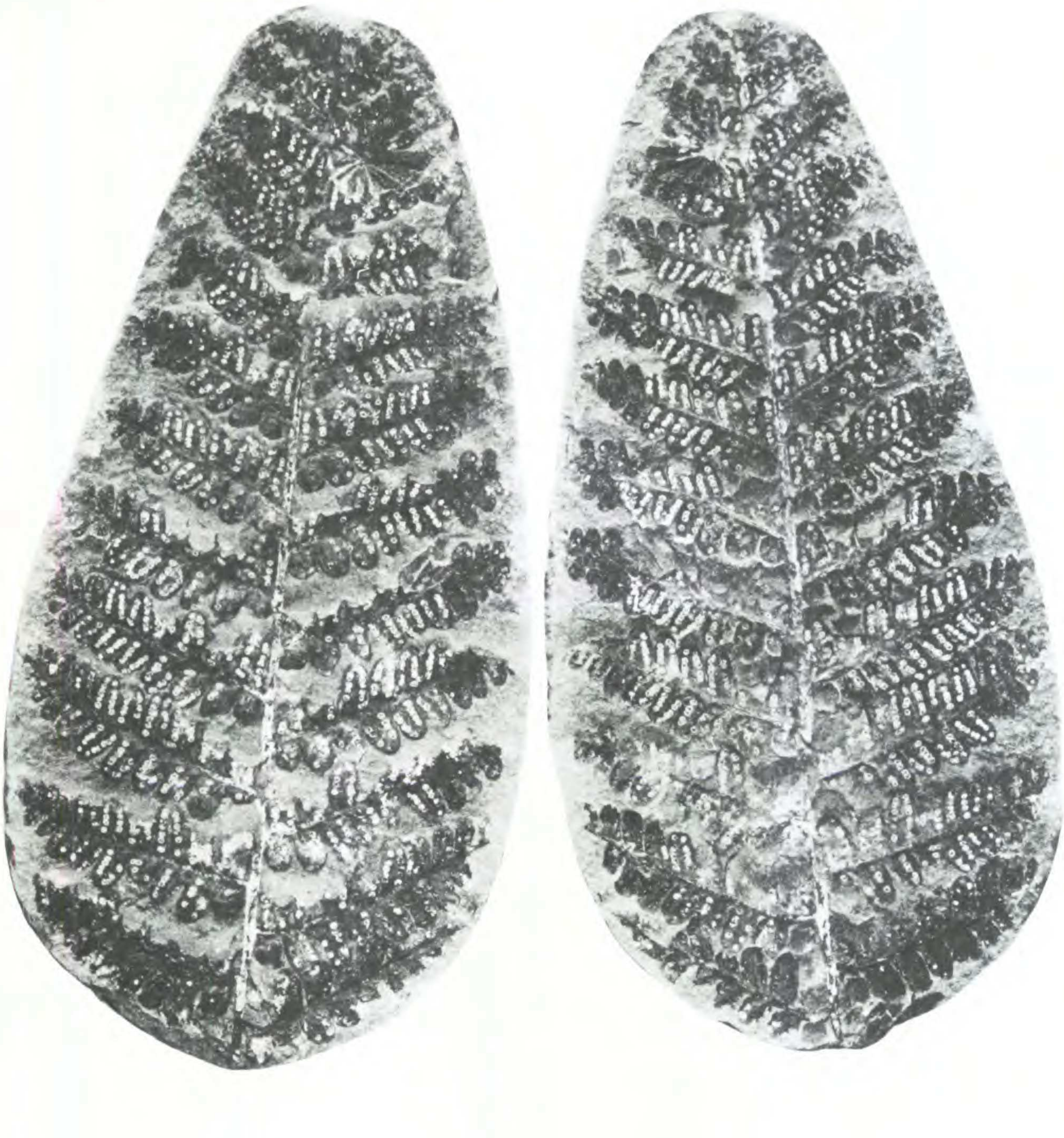
It will be observed that this diagnosis is in part unsatisfactory.

Oligocarpia vera *Darrah sp.nov.* 5 figures.

Frond probably large, tripinnatifid(quadripinnatifid?); foliage pecopteroid; rachis smooth, occasionally minutely punctate; primary pinnae unknown; "secondary" pinnae alternate, oblique, departing at an angle of 60 degrees. Pinnules ovate, alternate, close, short and robust; apex obtuse, rounded. Pinnules thin, nervation distinct. Veins fork at a wide angle and traverse the lamina in a flexuous

EXPLANATION OF THE ILLUSTRATION

OLIGOCARPIA VERA *Darrah*. Counterparts of the type specimen. The small sori, which are incrusted with calcite, are borne upon typical pecopteroid foliage. Natural size. Carboniferous: Allegheny: Mazon Creek, Illinois. F.O.Thompson Collection.



path. Sori large, placed at the ends of the veins, on the lower surface of the frond. Sporangia 4 to 6 in number, independent, placed in a ring. Sporangia annulate with the annulus composed of one row of cells. Sporangia 35-45 mm. long, 20 mm. wide. Spores numerous (hundreds), subspherical, smooth, 35–40 μ. in diameter.

HOLOTYPE No. 18704 F. O. Thompson Collection in the Botanical Museum of Harvard University.

This new species is clearly referable to the group of *Oligocarpia gutbieri*, but is readily distinguished by having a uniseriate annulus and by having robust pecopteroid foliage.

Oligocarpia vera is distinguished from *O. kansasensis* Sellards[2] by its greater size, its pecopteroid rather than sphenopteroid foliage, its smooth rather than punctate rachis, its absence of "thorns" on the rachis, and in not having the tertiary pinnules overlapping. In *O. kansasensis* the details of the sorus are not known. The Kansas species occurs in the Lawrence Shales, Douglas Formation.

Oligocarpia vera differs from *O. alabamensis* Lesquereux in having well developed terminal pinnules, pecopteroid instead of sphenopteroid foliage, and more flexuous venation. It differs also from *O. missouriensis* D. White[4] in having pecopteroid foliage, much greater size, pinnules which are not crenulate and do not depart at right angles from the rachis of the pinna. In *O. missouriensis* the details of the sori and sporangia are not known.

Oligocarpia flagellaris Lesquereux[5] has sphenopteroid foliage and perhaps should be excluded from this genus. Specimen No. 7596 from Morris, Illinois (Lesquereux's No. P.294) is a *Sphenopteris* and the fructification is indistinct. *O. vera* bears no relationship to this species.

It now appears to be clear that the foliage of *Oligo-*

carpia is usually of the sphenopteroid type and frequently investigators, in discussing the genus, fail to consider the fact that the foliage may be pecopteroid.

The chief species of the sphenopteroid series is *Oligocarpia brongniarti* Stur[6] and the best known of the pecopteroid series is *O. gutbieri* Goeppert,[7] although even in this species the foliage is more or less sphenopteroid.

In all of the species in which the sporangia are known, there has been observed a more or less transverse annulus which resembles in great detail that found in the genus *Gleichenia*. There is some evidence indicating that, at least in a few species, the sorus is synangial, even though each sporangium is annulate. In all of the species the sorus is circular and consists of 3–6 (10) pyriform sporangia which Zeiller describes as bearing a complete transverse annulus.

Stur[8] believed that the "annulus" is merely a type of preservation of the exannulate sporangia. Solms-Laubach[9] agreed with the opinion of Stur and went further in saying, "I am still obliged to assent to Stur's opinion of the independent existence of the annulus. If we look at the obliquely conical sporangium from above, we get a profile view of one or more transverse rows of the strongly thickened cell-walls, and may mistake them for an annulus: but we find that whenever we alter the position of a detached sporangium, the supposed annulus appears in another place."

This annulus is not clearly understood. Kidston found that the annulus may be biseriate or triseriate, although earlier work indicated that the annulus was uniseriate. It has been implied that if Kidston's observations prove to be typical for most (if not all) species of *Oligocarpia* then their affinity with the Gleicheniaceae may be challenged. However, it is to be observed that in only a few species of *Oligocarpia* is the sorus known and Kidston's

opinion is practically limited to *O.gutbieri*. It does not follow that the case for or against the existence of the Paleozoic Gleicheniaceae rests on this point.

Synangia do occur occasionally in the living genus *Gleichenia*. In other words, the teratological occurrence of a biseriate annulus and a synangial condition of the sorus in *Gleichenia* admit the possibility and propriety of including *Oligocarpia* in the Gleicheniaceae.

The sorus of *Oligocarpia* may be compared with several types of fructifications attributed to marattiaceous ferns. A case in point is *Asterotheca* notably *Asterotheca miltoni (Artis)*. *Asterotheca* belongs to the Carboniferous eusporangiate complex which can be referred to the Marattiaceae or to a closely allied family. This similarity may indicate phylogenetical relationship. Bower has suggested that the type of sorus in *Gleichenia* is essentially like that of the Marattiaceae—that is, derived from it.

Thus there are two relationships of the sorus which are in doubt. If Kidston is correct in regarding the sorus to be an annulate synangium, then we observe a type of fructification which, as far as I am aware, is not normally found in any existing ferns. On the other hand, if there are species of the genus which have a uniseriate annulus and in which the sporangia are free, then there is no reason for excluding *Oligocarpia* from the Gleicheniaceae.

The Gleicheniaceae are a decadent group which represent but a small remnant of a former diverse stock. It is to be expected that the earlier members of the group fail to conform to the narrow limits of the residual stock which has lost much of its plasticity.

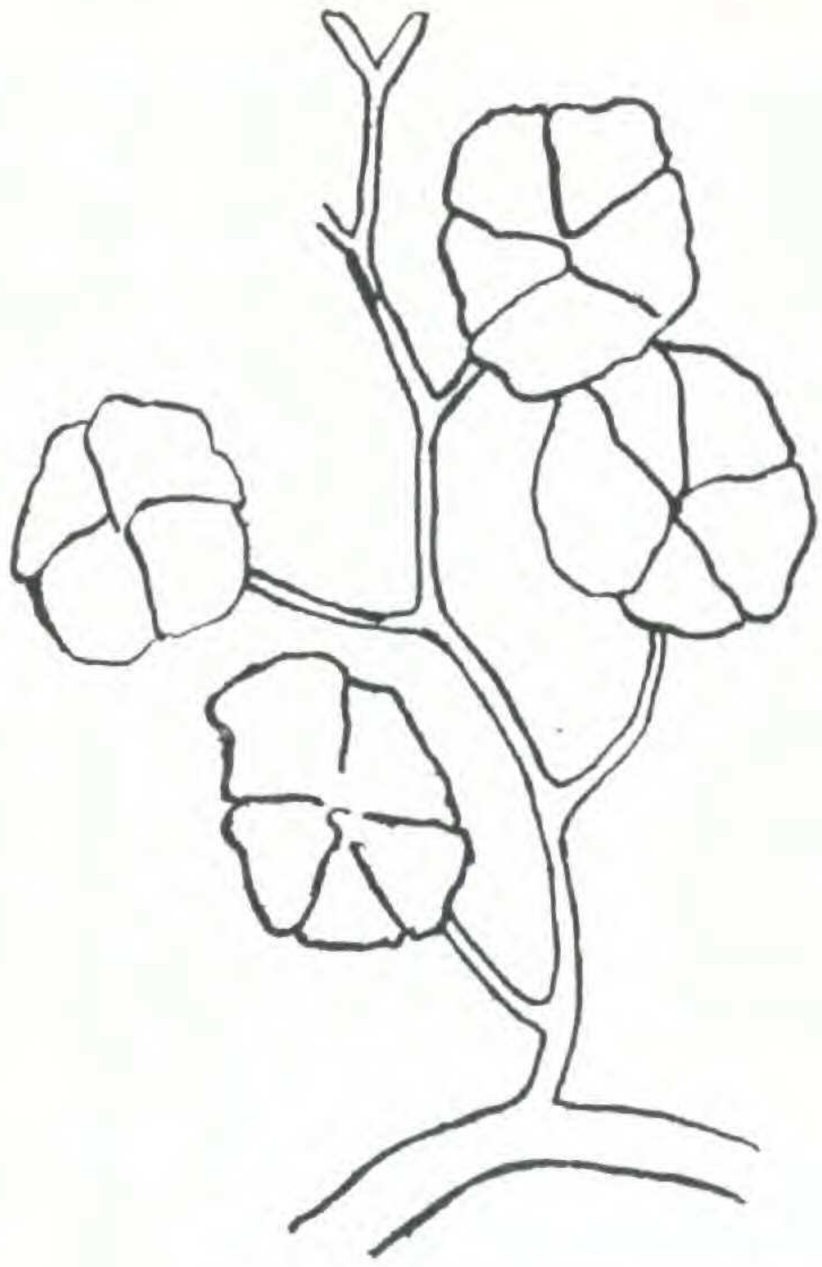
Nevertheless among the comparatively few existing members of the family we encounter several remarkable characters of variability. The sori of the Gleicheniaceae are superficial and are borne in a single row on both sides of the midrib. The number of sporangia in a sorus varies

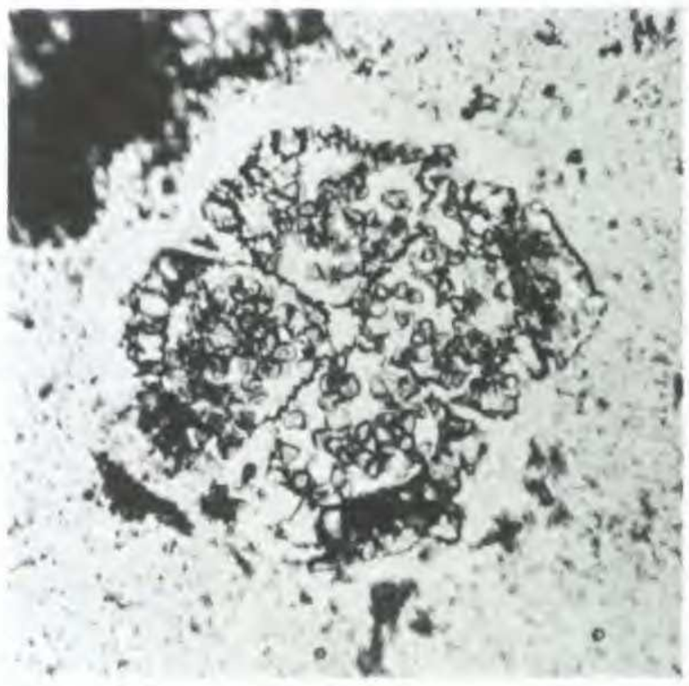
EXPLANATION OF THE ILLUSTRATION

OLIGOCARPIA VERA *Darrah*. The figure at top shows how the sporangia are borne at the ends of secondary veins. Drawn ten times natural size. The lamina is not indicated. The figure in middle is redrawn from Stur. It shows a sorus composed of four sporangia. Twenty times natural size.

Both drawings executed by G. W. DILLON

The figure at bottom is a photograph of a nitrocellulose peel made from the type specimen. It shows four annulate sporangia filled with the subspherical spores. Fifteen times natural size.





from 2 to 6 in most of the species, but in a few the number may be 10 or even 12. There is considerable variation on a single fertile segment. There is no indusium and the sorus is naked. Bower[10] remarks that in the extreme cases of the gleicheniaceous sorus, with a large number of sporangia some of which are displaced by pressure, we find a condition which suggests the sori of both the Marattiaceae and the Cyatheaceae. In the former, the typical sorus is a single row of sporangia which surrounds a low receptacle. In the latter, the receptacle is elongated and its apex is covered with sporangia. In the eusporangiate Marattiaceae the spore-output is generally very large and in the higher ferns the spore-output is usually smaller. In the comprehensive genus *Gleichenia* it has been observed that the spore-output varies from 128 to 1024 and the number 256 is most frequent. *Stromatopteris*, on the basis of several spore counts, has a potential output of 512. *Platyzoma* is particularly important in this connection, because it exhibits a condition which is considered as incipient heterospory. The sporangia are of two sizes, the smaller of which are more abundant. The number of spores varies from 16 downward in the larger sporangia, and from 32 downward in the smaller sporangia (Bower). There are intergrades between the extremes.

This heterogeneous complex probably represents several relict lines of descent from a more extensive group, and the morphology of the spore-bearing members makes this suggestion more probable.

It is advisable to append to this dicussion a few additional observations, though they are included only for the sake of completeness.

Oligocarpia brongniarti Stur was believed by Zeiller[11] to have a uniseriate annulus, but recently De Pape and Carpentier[12] have figured a specimen which indicates that the annulus of the sporangium may be biseriate.

Some years ago Stopes[13] recognized that Dawson's *Sphenopteris splendens*[14] was identical with *Oligocarpia brongniarti* Stur[15] and that Dawson's specific name held priority. Consequently, the species was renamed *Oligocarpia splendens*. Kidston, however, rejected this new name and retained the name given by Stur, because the figures published by Dawson are of no value. This is the usual procedure adopted by paleobotanists. The New Brunswick plant, then, is known as *O. brongniarti*.

Most of the species of *Oligocarpia* are of upper Carboniferous age. The rocks of the Pennsylvanian formations of northern Illinois have yielded three species in addition to *O. vera*. A fourth, *Oligocarpia flagellaris* Lesquereux, is to be excluded from this genus; it is better known as *Sphenopteris flagellaris* Lesquereux. The reference of this species to the form-genus *Sphenopteris* restores to validity the original name used by Lesquereux in the *Journal of the Boston Society of Natural History* in 1854 (volume 6, page 420) and in the *Geology of Pennsylvania* in 1858 (page 862). In the *Coal Flora* (page 267), Lesquereux remarked that the habitat is "South Salem Vein, Tunnel of Sharp Mountain, near Pottsville" [Pennsylvania] and "no other specimens have been found than the one figured." This statement was erroneous, for according to Lesquereux's manuscript catalogue, he had referred specimens from Illinois, West Virginia, and western Pennsylvania to this species.

Lesquereux reported a specimen of *Oligocarpia alabamensis* from Morris, Illinois, but this record is in error. David White[16] suggested that it should have been renamed and that the specimen belonged rather to *O. missouriensis*. I have seen no specimen from Illinois referable to either *O. alabamensis* or *O. missouriensis*. Tentatively, I record the occurrence of the latter species from Illinois on the strength of White's remarks.

Lesquereux also recorded *Oligocarpia cf. gutbieri* from Mazon Creek. White was doubtful of the accuracy of Lesquereux's determination, but I do not share this doubt. I have seen six specimens referable to this species all from Braidwood and Mazon Creek. My concept of *O. gutbieri* is based entirely upon the descriptions published in western Europe, although I have relied chiefly upon the opinions of Stur and Kidston.

In summarizing, it is observed that only two undoubted species of *Oligocarpia* occur in the Mazon Creek flora of Illinois: *O. gutbieri* Goeppert, and *O. vera* Darrah which is described in this paper. It is possible that *O. missouriensis* D. White also occurs in this region, but the record is questionable. The record of *O. alabamensis* Lesquereux is erroneous.

Oligocarpia vera is one of the pecopteroid species of *Oligocarpia* and is remarkable for its uniseriate annulus. The evidence regarding the systematic position of the genus is here reviewed and it is concluded that it belongs properly to the existing family Gleicheniaceae.

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